

# HARD HANDOFF METHOD BETWEEN AN ASYNCHRONOUS CDMA SYSTEM AND A SYNCHRONOUS CDMA SYSTEM

## TECHNICAL FIELD

The present invention relates to a hard handoff method between an asynchronous CDMA (Code Division Multiple Access) system and a synchronous CDMA system, which receives all necessary information for the handoff with a synchronous CDMA base station (especially, second generation IS95 base station) without disconnecting communication with an asynchronous CDMA base station (especially, third generation 3GPP DS base station).

## 10 BACKGROUND OF THE INVENTION

Conventional handoff method is restricted within the handoff of identical systems and assumes that mobile terminals and a network are synchronized by GPS (Global Positioning System). This assumption is no longer valid because the third generation 3GPP (Global Partnership Project) DS (Direct Spreading) system works at an asynchronous mode.

To make the handoff between a mobile terminal communicating with the third generation 3GPP DS system and the second generation IS95 system, a connection with the third generation 3GPP DS system must be terminated beforehand. It is because 3GPP DS systems work on the asynchronous mode and IS95 synchronous information cannot be transmitted to the mobile terminal.

Consequently, handoff success rate drops because acquiring pilot channel of second generation IS95 system, interpreting synchronous channel message, and establishing traffic channels have to be performed and therefore mobile terminals stay in disconnected state for a relatively longtime.

## 25 SUMMARY OF THE INVENTION

A hard handoff method between an asynchronous CDMA (Code Division Multiple Access) system and a synchronous CDMA system is provided.

A hard handoff method between the asynchronous CDMA system and the synchronous CDMA system in accordance with an embodiment of the present invention includes following steps. A first step is to transmit asynchronous CDMA channels from the synchronous CDMA base stations with a purpose of synchronizing a handoff time at the synchronous CDMA base station and a code used at the synchronous CDMA base station. The transmission is done by a mobile terminal that is in communication with an asynchronous CDMA base station. The transmission is a part of handoff process and the mobile terminal performs the hard handoff to the synchronous CDMA base station. A second step is to report a measured result to the asynchronous CDMA base station on the basis of an intensity of an asynchronous CDMA pilot channel received from an adjacent synchronous CDMA base station. The reporting is done by the mobile terminal. A third step is to transmit a handoff request message to the synchronous CDMA base station on the basis of the measured result. The transmission is done by the asynchronous CDMA base station. A fourth step is to transmit an information necessary for handoff to the asynchronous CDMA base station. The transmission is done by the synchronous CDMA base station that receives the handoff request message. A fifth step is to perform the hard handoff to the synchronous CDMA base station. The hard handoff is performed by the mobile terminal that receives the information through a traffic channel from the asynchronous CDMA base station.

Preferably, the first step includes following steps. A first step is to transmit an asynchronous CDMA synchronization channel and a common pilot channel. A second step is to synchronize the asynchronous CDMA synchronization channel and the common pilot channel with a starting point of an synchronous pilot channel, the synchronous pilot channel being transmitted from the synchronous CDMA base station.

Preferably, the second step includes following steps. A first step is to measure an intensity of signals received from the asynchronous CDMA base station and the adjacent synchronous CDMA base station using the asynchronous CDMA synchronization channel and the common pilot channel. The measurement is done by the mobile terminal that is in communication with the asynchronous CDMA base station. A second step is to report the intensity of signals and an information regarding

the synchronous CDMA base station. The report is done by the mobile terminal if the intensity of signals received from the synchronous CDMA base station is bigger than an intensity of signals received from the asynchronous CDMA base station by a predetermined value. A third step is to return to the measuring step if the intensity of signals received from the synchronous CDMA base station is not bigger than the intensity of signals received from the asynchronous CDMA base station by the predetermined value.

Preferably, the information necessary to perform the handoff includes a starting point of the hard handoff, a long code state at the starting point of the hard handoff, an offset index of a pilot PN (Pseudo Noise) sequence, a code channel index used in forward traffic channel, and an offset value regarding the traffic channel.

Preferably, the fifth step includes following steps. A first step is to receive the information from the asynchronous CDMA base station through a traffic channel. A second step is to release the traffic channel established with the asynchronous CDMA base station and establish a traffic channel with the synchronous CDMA base station. A third step is to exchange an available frame between the mobile terminal and the synchronous CDMA base station through the established traffic channel and confirm a handoff completion. A fourth step is to release resources between the asynchronous CDMA base station and a switch. The synchronous CDMA base station reports the handoff completion to the switch.

Preferably, the traffic channel is established between the mobile terminal and the synchronous CDMA base station using the starting point of the hard handoff, the long code state at the starting point of the hard handoff, the offset index of the pilot PN sequence, the code channel index used in the forward traffic channel, and the offset value regarding the traffic channel.

Preferably, the starting point of the hard handoff is determined by calculating how many frames of the common pilot channel have passed at the asynchronous CDMA base station from the moment when the mobile terminal receives information.

A computer readable medium for recording program, which provides a hard handoff method in a CDMA system being equipped with microprocessors is provided. The program includes following steps. A step is to report a measured result to an asynchronous CDMA base station on the basis of an intensity of an asynchronous

5 CDMA pilot channel received from an adjacent synchronous CDMA base station. The reporting is done by a mobile terminal. A step is to transmit a handoff request message to the synchronous CDMA base station on the basis of the measured result. A step is to transmit an information to the asynchronous CDMA base station. The transmission is done by the synchronous CDMA base station that receives the handoff request message.

10 A step is to perform a hard handoff to the synchronous CDMA base station. The hard handoff is performed by the mobile terminal that receives the information through a traffic channel from the asynchronous CDMA base station.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The embodiments of the present invention will be explained with

15 reference to the accompanying drawings, in which:

Figure 1 is a diagram illustrating a wireless communication network in which the method in accordance with an embodiment of the present invention is applied;

Figure 2 is a timing diagram illustrating channels transmitted between an

20 asynchronous CDMA base station and a synchronous CDMA base station;

Figure 3 is a diagram illustrating an embodiment of the present invention; and

Figure 4 is a flow diagram illustrating a handoff method between an asynchronous CDMA system and a synchronous CDMA system in accordance with an

25 embodiment of the present invention.

#### DETAILED DESCRIPTION OF THE INVENTION

A hard handoff method in accordance with an embodiment of the present invention supports reliable handoff between a base station of asynchronous CDMA

system, especially, asynchronous third generation 3GPP DS system, and a base station of synchronous CDMA system, especially second generation IS95 system. In the method in accordance with an embodiment of the present invention, the mobile terminal communication with a third generation 3GPP DS system measures intensity of received signals from a second generation IS95 system and reports the result to the third generation 3GPP DS system. Also, a hard handoff method in accordance with an embodiment of the present invention determines whether handoff between a third generation 3GPP DS system and a second generation IS95 system is necessary on the basis of the reported information. At the moment, a base station of the second generation IS95 system provides necessary information for handoff to the base station of the third generation 3GPP DS system. The mobile terminal receives the information through the 3GPP DS system that is currently under communication with the mobile terminal and performs hard handoff to the base station of the second generation IS95 system.

For the method stated above, a base station of second generation IS95 adjacent to a base station of third generation 3GPP DS transmits synchronization channel and common pilot channel of the base station third generation 3GPP DS additionally.

Figure 1 is a diagram illustrating a wireless communication network in which the method in accordance with an embodiment of the present invention is applied.

Handoff is required for cases in which a base station of second generation IS95 is installed to be adjacent to a base station of third generation 3GPP DS. Handoff is not needed for communications between base stations of second generation IS95. Likewise, handoff is not needed for communications between base stations of third generation 3GPP DS.

Figure 2 is a timing diagram illustrating channels transmitted between an asynchronous CDMA base station and a synchronous CDMA base station. A base station of second generation IS95 system adjacent to a base station of third generation 3GPP DS system transmits synchronization channel of 3GPP DS, common pilot

second generation IS95 channel.

Third generation 3GPP DS synchronization channel and common pilot channel are synchronized with a starting point of second generation IS95 pilot channel.

Third generation 3GPP DS synchronization channel and common pilot channel are delayed by PN (Pseudo Noise) offset from even second and then transmitted. Third generation 3GPP DS common pilot channel of 10msec iterates eight times in second generation IS95 synchronization channel super frame. The reason why third generation 3GPP DS synchronization channel is synchronized and then transmitted with pilot channel in synchronous second generation IS95 base station is that a synchronization for handoff performance is required between a network and a terminal.

invention.

15 A mobile terminal communicates with a base station of third generation 3GPP DS through a dedicated physical channel and monitors common pilot channel and synchronization channel of other base stations adjacent to the base station of a third generation 3GPP DS. The mobile terminal measures intensity of asynchronous cells and synchronous cells at step 302. When a condition is satisfied for a report, for example, if

20 the intensity of asynchronous cells and synchronous cells is bigger than signal intensity of currently communicating base station by a certain value, the mobile terminal reports the intensity of asynchronous cells and synchronous cells and information regarding which base stations are related with the intensity to the network at step 303. This report is named measurement report.

3GPP DS system uses the intensity

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25 An asynchronous third generation 3GPP DS system uses the intensity and the information reported by the mobile terminal and determines whether handoff is to be performed and which base station performs handoff. If the information indicates a second generation IS95 base station, the network recognizes that handoff is required for the second generation IS95 base station.

When a third generation 3GPP DS base station notifies a request of handoff to a switch (Handoff required) at step 305, the switch notifies a request of handoff to a second generation IS95 base station (Handoff request) at step 306.

- After receiving the request messages, the second generation IS95 base station transmits the necessary information for handoff to the third generation 3GPP DS base station at step 307 and 308. The necessary information includes information regarding when handoff is performed, long code state at the moment of handoff, offset index of pilot PN sequence with 64 chip unit, code channel index used for forward direction traffic channel, and offset value if offset is applied to traffic channel (Handoff Request ACK, Handoff Command).

- The third generation 3GPP DS base station transmits the information received from a second generation IS95 base station to the mobile terminal through the established signal channel at step 309 (Inter-System Handoff Command). Once the mobile terminal receives the inter-system handoff command successfully, the mobile terminal notifies it to the third generation 3GPP DS base station at step 310 (link layer confirmation response (L2: Data Ack)). Then, the third generation 3GPP DS base station sends handoff commenced message to the switch at step 311.

- The mobile terminal receiving Inter-System Handoff Command confirms when handoff is performed on the basis of information contained in the message. The starting point for handoff is determined with 10ms unit after the message is received. The mobile terminal establishes forward direction traffic channel or reverse direction traffic channel on the basis of information such as long code state at handoff, offset index of pilot PN sequence with 64 chip unit, code channel index used for forward direction traffic channel, and offset value if offset is applied to traffic channel.
- When available frame is received through the established traffic channel, hard handoff between the third generation 3GPP DS base station and the second IS95 base station is successfully completed at step 312. The mobile terminal transmits handoff completion message to the second generation IS95 base station at step 313 and the message notifies requested handoff is done successfully.

After receiving a report saying that handoff is successfully completed, the second generation IS95 base station notifies that it received handoff completion message successfully to the mobile terminal at step 314 (LAC ACK). Then, resources held for communication with the mobile terminal in third generation 3GPP DS network are released. That is, the second generation IS95 base station notifies mobile switch that the handoff is completed (Handoff Complete) at step 315. When the mobile switch requests the third generation 3GPP DS base station to release resources (Clear Command) at step 316, the third generation 3GPP DS base station releases the resources and notifies the release to mobile switch (Clear Complete) at step 317.

Figure 4 is a flow diagram illustrating a handoff method between asynchronous CDMA system and synchronous CDMA system in accordance with an embodiment of the present invention.

Even though a mobile terminal in communication with a third generation 3GPP DS base station doesn't recognize a second generation IS95 base station, it maintains 10msec time information for measuring signal intensity of common pilot channel transmitted from the second generation IS95 base station. As shown in Figure 2, the 10msec channel is transmitted with the second generation IS95 synchronization channel super frame (80msec) using the same starting point. In this case, starting point of the third generation 3GPP common pilot channel and starting point of the second generation IS95 synchronization channel super frame are identical in 80msec unit.

In an embodiment of the present invention, timing for handoff between a mobile terminal and a second generation IS95 base station is synchronized in 10msec frame of the third generation 3GPP DS common pilot channel.

At of Figure 4, a second generation IS95 base station receiving handoff request selects the closest 80msec starting point that is bigger than delay occurred between the network and wireless range. Then, the second generation IS95 base station calculates how many third generation 3GPP DS common pilot channel frames of 10msec have passed. The second generation IS95 base station transmits handoff confirmation message to the third generation 3GPP DS base station. The handoff confirmation message includes the calculated value, long code state at the



moment, offset index of pilot PN sequence with 64 chip unit, code channel index used for forward direction traffic channel, and offset value if offset is applied to traffic channel. The third generation 3GPP DS base station receives the message and passes it to the mobile terminal through established signal channel.

5           At of Figure 4, the mobile terminal receives the information by way of handoff message and performs handoff with the received information after a certain number of common pilot channel (10msec) frames passes. The number of frames is determined by the second generation IS95 base station.

10           As stated above, a hard handoff method in accordance with an embodiment of the present invention supports reliable handoff between a base station of asynchronous CDMA system, e.g., asynchronous third generation 3GPP DS system, and a base station of synchronous CDMA system, e.g., second generation IS95 system. A handoff with a second generation IS95 base station is performed at a particular time specified by the network after necessary information is received without disconnecting  
15           communication with a third generation 3GPP DS station. Therefore, time frame for disconnected state gets minimized and hard handoff success rate between a third generation 3GPP DS system and a second generation IS95 system is significantly improved.

20           Although representative embodiments of the present invention have been disclosed for illustrative purpose, those who are skilled in the art will appreciate that various modifications, additions and substitutions are possible without departing from the scope and spirit of the present invention as defined in the accompanying claims.